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Impact of Laptev Sea flaw polynyas on the atmospheric boundary layer and ice production using idealized mesoscale simulations

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The interaction between polynyas in the Laptev Sea and the atmospheric boundary layer is examined with the regional, nonhydrostatic atmosphere model COSMO. A thermodynamic sea ice model is used to consider the response of sea ice surface temperature to idealized atmospheric forcing. Cold wintertime conditions are investigated with sea ice-ocean temperature differences up to 40 K combined with different wind speed by varying wind direction. The Laptev Sea flaw polynyas strongly modify the ABL. Strong wind regimes lead to a more shallow mixed layer with strong near-surface modifications, while weaker wind regimes show a deeper well-mixed convective boundary layer. Shallow mesoscale circulations occur in the vicinity of ice-free and thin ice covered polynyas. They are forced by large surface energy fluxes of up to 958 Wm-2, strong low-level thermally induced convergence, and additionally, cold air flow from the orographic structure at Taymir-Peninsula in the western Laptev Sea region. Based on the surface energy balance, we derive potential sea ice production rates between 8 cm d-1 and 25 cm d-1 in the Laptev Sea polynyas. The range is mainly controlled by the assumption whether the polynyas are ice-free or covered by thin ice and by the wind strength.